Today: More Clouds
Skew T, stable vs unstable, relative humidity

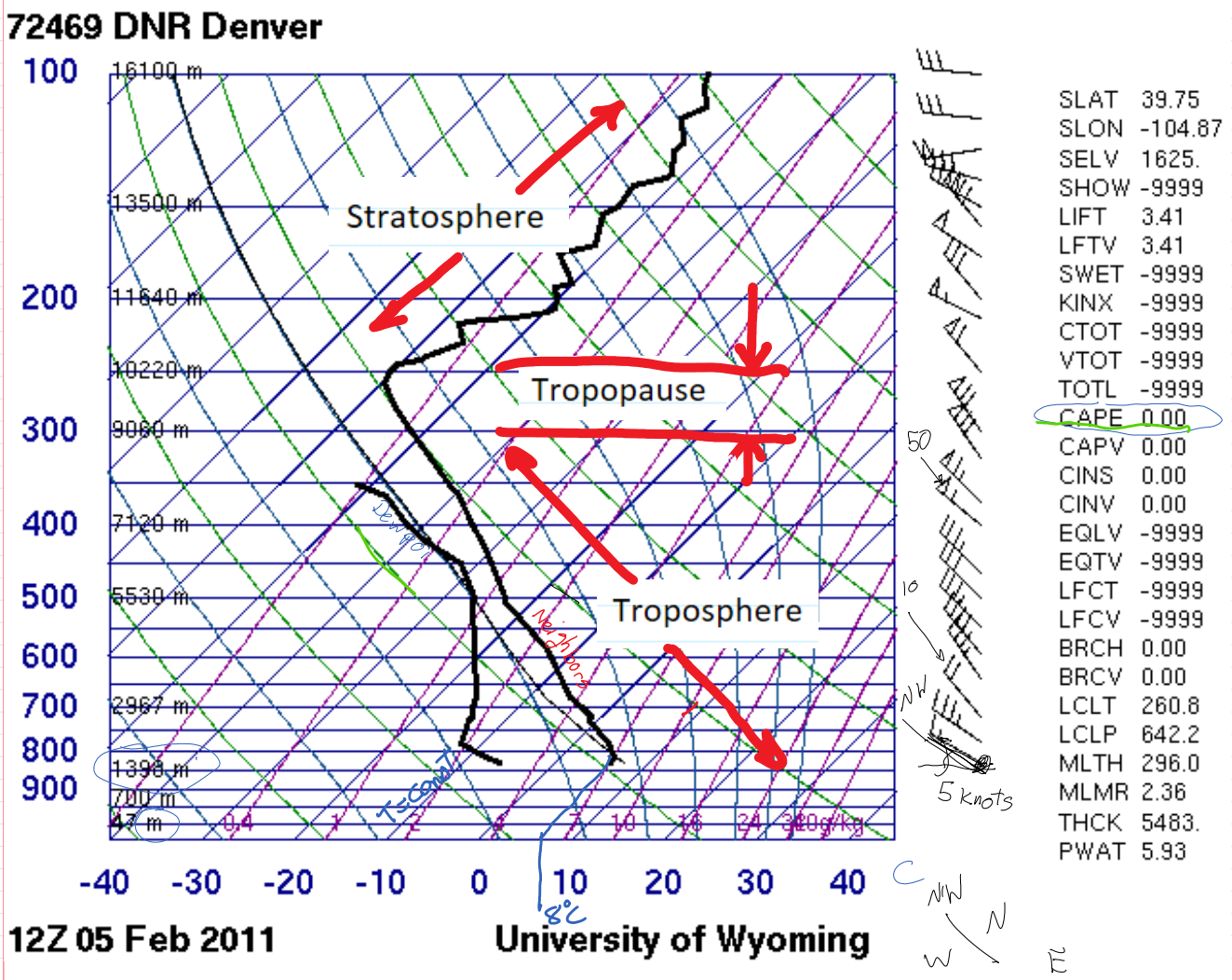
Skew-T continued:
Tells stability, and thus cloud type: **STABLE=flat clouds, stratus types**. **UNSTABLE = puffy clouds, cumulus varieties**
Also predicts cloud elevations; low, middle (alto), high (cirro)

NO VERTICAL GRID?

So many lines! How many kinds?

Horizontal blue	Constant pressure isobar
Angled blue	Constant temperature; isotherm. Angle ↗ SKEW T
Angle/curve green	Dry adiabat. A dry parcel will follow this temperature line if lifted adiabatically (without heat transfer)
Angle/curve blue	Moist, saturated adiabatic lapse rate. Air in a cloud will follow this temperature line if lifted adiabatically
Purple	Lines of constant mixing ratio; absolute humidity for saturation.
Heavy black	Right line is temperature profile. Left line is dew point
Light black	Adiabat starting at the top of the boundary layer

Basics of reading Skew T: http://www.theweatherprediction.com/thermo/skewt/
Skew T Mastery: https://www.meted.ucar.edu/loginForm.php?urlPath=mesoprim/skewt#



= STABLE if CAPE > 0 unstable

Starting parcel

1. Starting parcel
2. Raise it, cool it adiabatically (move up along the adiabat), perturb the system
   Check it, is my parcel warmer or cooler than the actual neighboring parcels?
   i. Cooler; more dense, wants to sink again, go back to origin STABLE
   ii. Warmer; less dense, wants to keep going up! UNSTABLE

Can start at any point on the actual temperature line. Go parallel to the adiabats. Choose dry adiabat (green) if below likely cloud level or wet (blue, saturated) if in a cloud.

Stable clouds = flat STRATUS type
Unstable clouds = puffy CUMULUS family

Atmosphere is all **stable if CAPE = 0** Convective Available Potential Energy
Has unstable layers if CAPE > 0. Thunderstorms if CAPE > 500 or so.

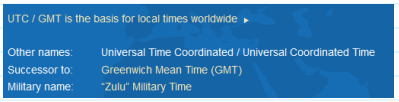
What was the surface weather on a given day?
https://www.wunderground.com/history/airport/KBDU/2016/9/30/DailyHistory.html?req_city=Boulder&req_state=CO&req_statename=&reqdb.zip=80301&reqdb.magic=1&reqdb.wmo=99999

RH

Dew point: Temperature a parcel would have to be cooled to in order to get condensation (dew)
Relative humidity: for a given absolute water vapor concentration, RH is high for low temperatures (close to dew point) and low for high temperatures. So T and RH time plots move opposite.

Other info on Skew-T: wind indicators, lifting condensation level.

Skew-T download tips: Skew-T Times:



12Z, Feb 14 = ~6 am Feb 14 here. Sunrise.
00Z, Feb 1**5** = ~6 **p**m Feb 14 here. Sunset.

Where are clouds? Where temperature is close to dew point, i.e. where the two heavy black lines come together.
Also, kink towards more steep in T line suggests clouds at that level.
Condensation = warming (opposite of evaporation = cooling on your skin)

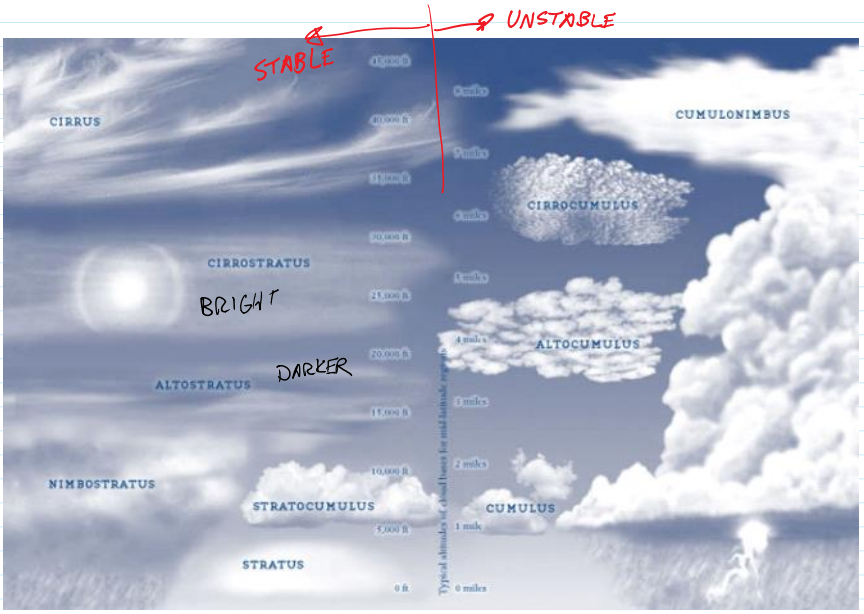
Can also get **local cloud height** from ATOC CU Boulder observation:
http://skywatch.colorado.edu/ or Flowvis.org>Links>Weather

1. Choose correct date. 12z Feb X is the 6 am sounding, 00z X+1 is the 6 pm sounding for date X
2. Choose plot, not text
3. Will open in next browser tab

http://weather.uwyo.edu/upperair/sounding.html

Clouds = droplets or ice MOVING UPWARDS

Lift mechanisms:
1. Instability
2. Orographics: terrain, mountains
3. Synoptic scale weather systems. Both at warm and cold fronts; cold air pushes under in a cold front, warm air overruns in a warm front.
4. Convergence: shoreline temperature differences



Clouds classified by

A. **Structure**: stratus = flat layers, cumulus = clumps
B. **Base height**: (2km)
   a. low: up to 6500 ft (above ground, not from sea level) and vertically developed (includes cumulonimbus)
   b. middle: 6500 to 23,000 ft (2-7 km)
   c. high: 16,000 to 45,000 OVERLAP (4.9 - 14 km)
   Cirrostratus: bright, no observable thickness, thin, uniform veil
   Altostratus: darker, may have noticeable thicker regions

- Cloud image submission: Include

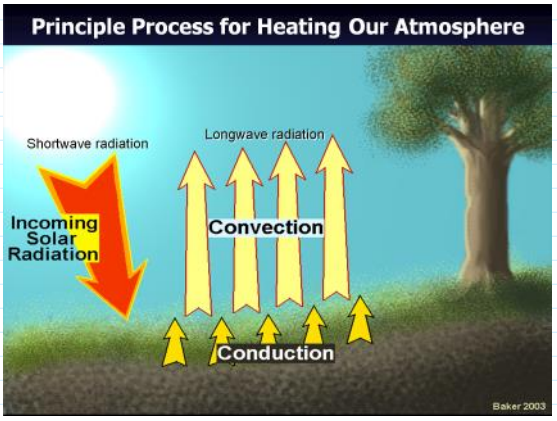
1) your edited image
2) your original (unedited) image
3) the appropriate Skew-T diagram
4) a short statement of cloud type and stable or unstable atm.
5) Post on Flowvis.org. Edit your post date to match your cloud date and time.

Clouds = droplets or ice MOVING UPWARDS

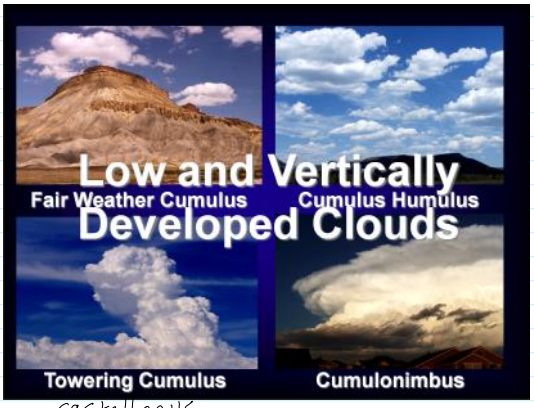
Lift mechanisms:

1. Instability: creates Cumulus clouds
2. Orographics: terrain, mountains
3. Synoptic scale weather systems; local instability. Both at warm and cold fronts; cold air pushes under in a cold front, warm air overruns in a warm front.
4. Convergence: shoreline temperature differences and cyclonic uplift

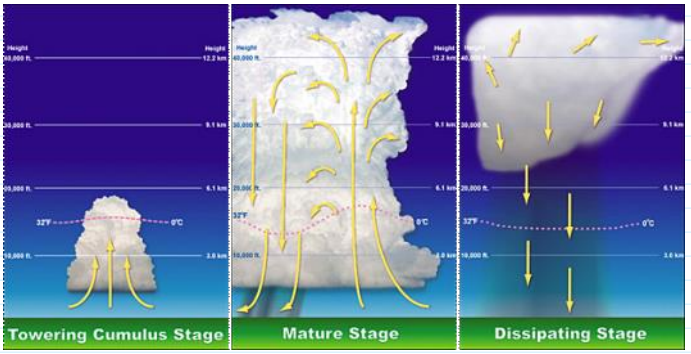
1. Instability driven clouds



If atmosphere is UNSTABLE, the heated air will continue to go up!



castellanus



Dark ground (plowed field etc.) can create local hot spot, starting a thermal. Mountain uplift can also trigger start of cycle.

http://www.k3jae.com/wxstormdevelopment.php

Thunderstorm anatomy, visible in Mike Olbinski's time lapse Monsoon IV: https://vimeo.com/239593389?ref=fb-share&1
Pyrocumulus = cloud formed at the top of a wildland fire smoke plume.

Stratocumulus: probably the world's most common cloud.

Stratocumulus Formation mechanisms:

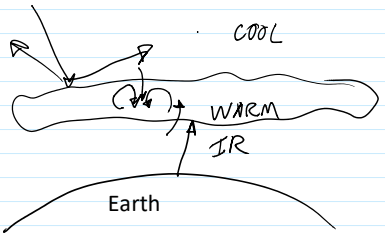
1) Cumulus joined together, caused by an inversion, a stable layer that stops upward convection
2) Stratus broken up. Top reflects UV, visible light, cools (maybe radiates IR to space). Bottom absorbs IR from the earth, warms

http://www.flowvis.org/category/flow-categories/clouds/stratocumulus/

http://www.flowvis.org/category/flow-categories/clouds/stratocumulus/

http://www.flowvis.org/2013/04/11/stratocumulus-boulder-co-18th-of-february-2013-at-1131-a-m/

2) Stratus broken up. Top reflects UV, visible light, cools (maybe radiates IR to space). Bottom absorbs IR from the earth, warms
Cool on top, warm on the bottom = unstable, wants to turn over, breaking up stratus layer.
Stratocumulus stratiformus



Partial rule of thumb
Cumulus = from instability; local uplift
Stratus = more stable, from widespread uplift

These are GENUS

For info on Species, Varieties and Accessory Clouds, see

Interesting book on how clouds were first classified and named ~1804, by Luke Howard
Richard Hamblyn, *The Invention of Clouds: How an Amateur Meteorologist Forged the Language of the Skies* (Picador, 2002).

Another rule of thumb (fingers,really)
Measure cloud element size with hand outstretched.
Cirrocumulus= elements smaller than one finger width
Altocumulus = elements between one and three finger widths
Cumulus = elements larger than three finger widths.

2: Orographic clouds, caused by topography, i.e. mountains

Orography (from the Greek όρος, hill, γραφία, to write) [Wikipedia]

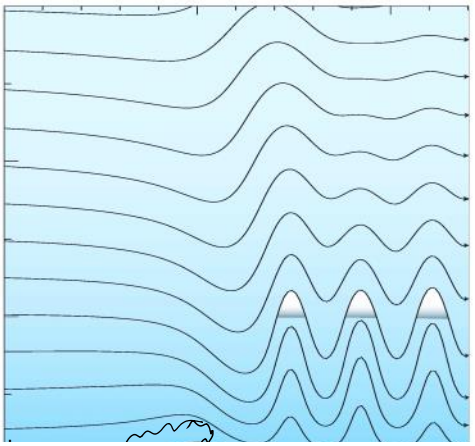
Most common interesting cloud in winter and spring is the

Altocumulus standing lenticularis (higher than 6500 ft above local ground level) ACSL
or
Stratocumulus lenticularis (lower)
or
Mountain Wave Cloud, trapped or lee

requires STABLE atmosphere: note exception to unstable/cumulus pairing

STANDING WAVE

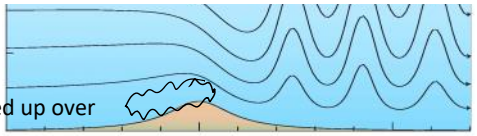
Clouds Produced by Vertically ***Trapped*** Mountain Waves



Thomas Carney et al., *AC 00-57 Hazardous Mountain Winds and Their Visual Indicators* (Federal Aviation Administration, 1997), http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/780437D88CBDAFD086256A94006FD5B8?OpenDocument.

Clouds that sit right on the Divide = FOEHN cloud wall.

Clouds that sit right on the Divide = FOEHN cloud wall. From air being forced up over the mountains



Fayne

Altocumulus lenticularis. Typically 1 to 5 wave crests.

Clouds stay stationary, but may move off and reform periodically

Ben Britton, FV 2010

If there's more wave crests, or short wavelengths, it's probably NOT a mountain wave cloud; more likely altocumulus undulatus, from gravity waves in the atmosphere, like ripples on a liquid surface.
http://www.colorado.edu/MCEN/flowvis/galleries/2007/assignment2.html

Tracy Eliasson FV 2007

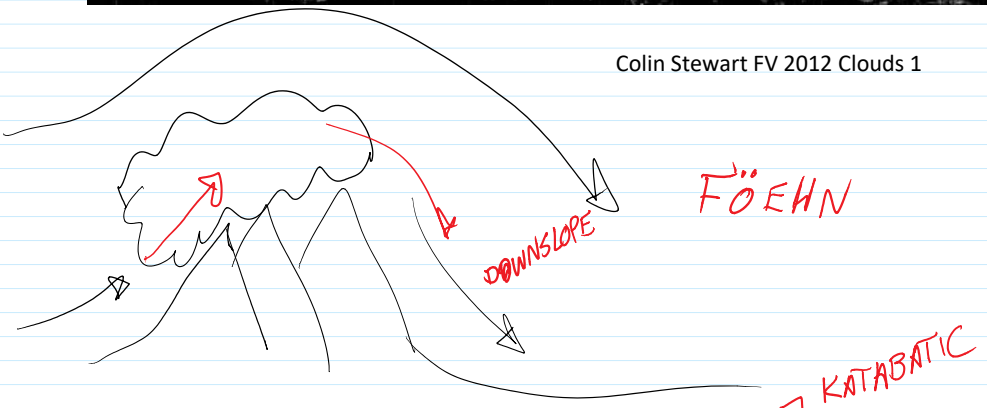
Could also be from wind shear, via the Kelvin Helmholtz instability

Rare to be able to see cross section like this

http://cloudappreciationsociety.org/collecting/terry-robinson/

Minute paper: Which way is the wind going?
Where is it faster?

Colin Stewart FV 2012 Clouds 1



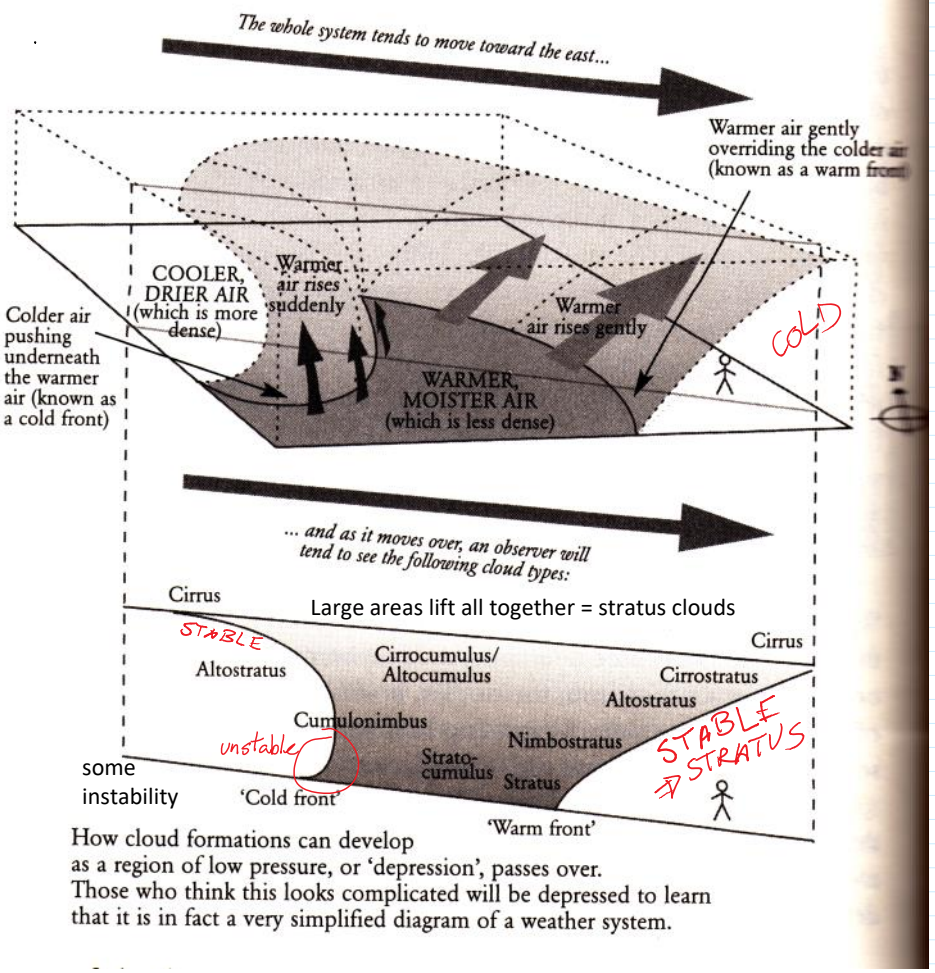
Foehn clouds suggest winds coming over the mountains: the presence of a CHINOOK (pre-cold-front, warm, strong, downslope winds, or a BORA (post-cold-front, cold, strong, downslope winds). Also called cap clouds.

3: Synoptic uplift = weather system clouds.

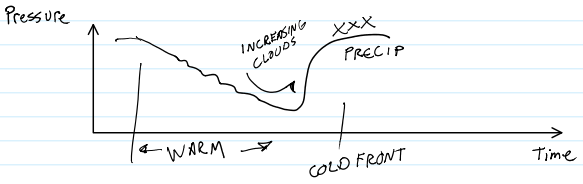
Weather system progressions; 'synoptic scale' uplifts (1000 km across).
Any type of cloud is possible.

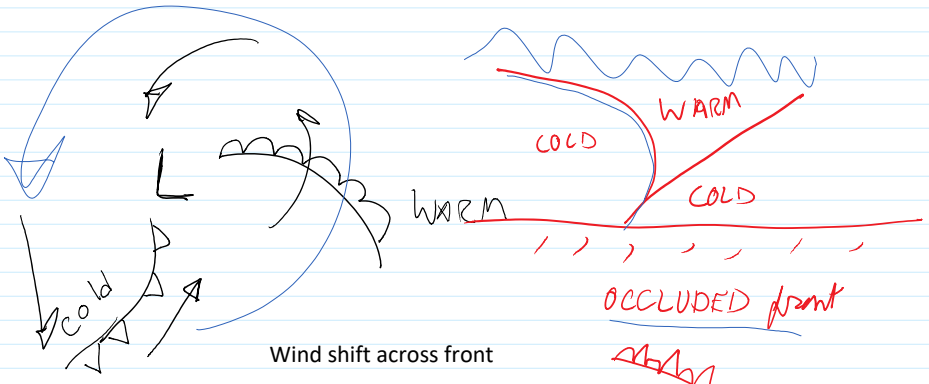
Inserted from: <file://C:\Users\hertzber\Documents\01CLASSES\FlowVis\Content\scanned images\TypWeatherSystem.tif>

The Cloudspotter's Guide pg186 THE HIGH CLOUDS



How cloud formations can develop as a region of low pressure, or 'depression', passes over. Those who think this looks complicated will be depressed to learn that it is in fact a very simplified diagram of a weather system.

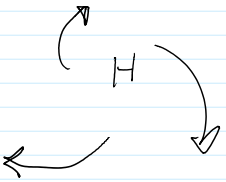


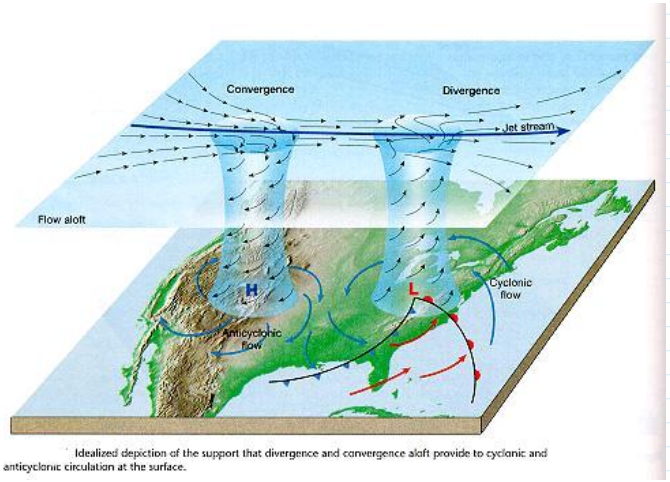


Wind shift across front

Low Pressure System: Air tries to move into low. Coriolis makes it turn left = counterclockwise circulation. Typically unstable. CYCLONIC

High pressure system: Air tries to move out. Coriolis makes it turn right = clockwise circulation. Weak or nonexistent fronts, so no instability. ANTICYCLONIC



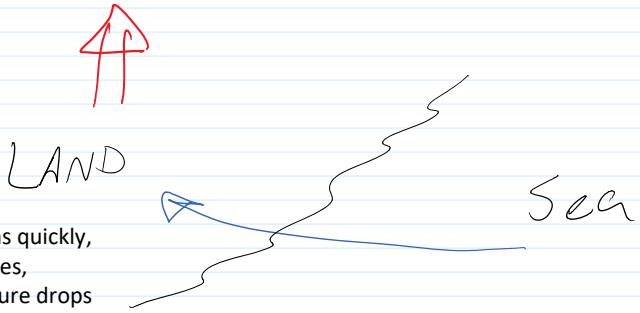


Idealized depiction of the support that divergence and convergence aloft provide to cyclonic and anticyclonic circulation at the surface.

Divergence aloft creates convergence and lift at surface. Pumping action.

http://earth.usc.edu/~stott/Catalina/WeatherPatterns.html

4: Convergence uplift along shorelines



warms quickly,
air rises,
pressure drops

Cool *sea breeze* is pulled in during daytime.
Land or *shore breeze* happens at night, when land cools more rapidly than the water.
Note: winds are named for where they come *from*

CloudClassificationTable.pdf; Copyrighted, but available in D2L.
Also see
***Cloud types for observers* (PDF, 4 MB) - Met Office** **45 pgs**

The Cloud Spotter's Guide
Gavin Pretor-Pinney. Perigee Press 2006

CLOUD CLASSIFICATION TABLE

Clouds are classified according to a Latin 'Linnean' system (similar to the one used for plants and animals), which is based on their heights and appearance. Most clouds fall into one of ten basic groups, known as 'genera'. They can further be defined as one of the possible 'species' for that genus, and any combination of the possible 'varieties'. There are also various accessory clouds and supplementary features that sometimes appear in conjunction with the main cloud types.
(If all this Latin freaks you out, don't worry – it freaks me out too.)

GENUS	SPECIES (CAN ONLY BE ONE)	VARIETIES (CAN BE MORE THAN ONE)	ACCESSORY CLOUDS AND SUPPLEMENTARY FEATURES	
PRINCIPAL CLOUDS			pileus	arcus
Cumulus	humilis	radiatus	velum	pannus
	mediocris		virga	tuba
	congestus		praecipitatio	
	fractus			
Cumulonimbus (extends through all three levels)	calvus		praecipitatio	pileus
	capillatus	(none)	virga	velum
			pannus	arcus
			incus	tuba
			mamma	
Stratus	nebulosus	opacus		
	fractus	translucidus	praecipitatio	
		undulatus		
Stratocumulus		translucidus		
		perlucidus		
	stratiformis	opacus	mamma	
	lenticularis	duplicatus	virga	
	castellanus	undulatus	praecipitatio	
		radiatus		
		lacunosus		
Altocumulus		translucidus		
	stratiformis	perlucidus		
	lenticularis	opacus	virga	
	castellanus	duplicatus	mamma	
	floccus	undulatus		
		radiatus		
		lacunosus		
Altostratus		translucidus	virga	
		opacus	praecipitatio	
	(none)	duplicatus	pannus	
		undulatus	mamma	
		radiatus		
Nimbostratus (extends through more than one level)	(none)	(none)	praecipitatio	
			virga	
			pannus	
Cirrus	fibratus	intortus		
	uncinus	radiatus		
	spissatus	vertebratus	mamma	
	castellanus	duplicatus		
	floccus			
Cirrocumulus	stratiformis			
	lenticularis	undulatus	virga	
	castellanus	lacunosus	mamma	
	floccus			
Cirrostratus	fibratus	duplicatus	(none)	
	nebulosus	undulatus		

HOW TO SPOT
CUMULUS CLOUDS

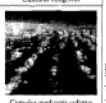
Cumulus are low, detached, puffy clouds that develop vertically in rising mounds, domes or towers, and have generally flat bases. Their upper parts often resemble cauliflowers and they appear brilliant white when reflecting high sunlight, but can look dark when the sun is behind them. Cumulus tend to be randomly scattered across the sky.

TYPICAL ALTITUDES*: 2,000–3,0000
WHERE THEY FORM: Worldwide, except in Antarctica (the ground is too cold for thermals).
PRECIPITATION (REACHING GROUND): Generally none, except for brief showers from congestus.

Cumulus humilis | Cumulus mediocris | Cumulus congestus

CUMULUS SPECIES:
HUMILIS: Minimal vertical extent. They look flattened and appear wider than they are tall. Do not cause precipitation.
MEDIOCRIS: Moderate vertical extent. Might show protuberances and sprouttings at the top. Appear as tall as they are wide. Do not cause precipitation.
CONGESTUS: Maximum vertical extent. The tops are like cauliflowers. Appear taller than they are wide. Cause brief downpours.
FRACTUS: Ragged edges and broken up. Can form in the moist air below rain clouds.

CUMULUS VARIETIES:
RADIATUS: When Cumulus have formed into rows, or 'cloud streets', which are roughly parallel to the wind direction. Due to perspective, the rows appear to converge towards the horizon.



Cumulus mediocris radiatus

NOT TO BE CONFUSED WITH...
STRATOCUMULUS: Cumulus clouds are detached, not joined into a layer like Stratocumulus.
ALTOCUMULUS: Cumulus are not usually as regularly spaced as a layer of the higher Altocumulus. The clouds also look larger than the clumps of the Altocumulus. When they are above the cloudspotter, Cumulus appear larger than the width of three fingers, held at arm's length.
CUMULONIMBUS: which often develops from a large Cumulus congestus. A cloud is still a Cumulus when its upper region has a sharp outline, compared with the softer top of the Cumulonimbus.

* These approximate altitudes (above the surface) are for mid-latitude regions.

HOW TO SPOT

CUMULONIMBUS CLOUDS

Cumulonimbus are thunderstorm clouds, characterised by their enormous height. They are typically tall enough to reach the top of the troposphere, where they spread out in plumes of ice particles that can appear smooth, fibrous or striated. They have dark bases and produce heavy showers – often of hail – which can be accompanied by thunder and lightning.

TYPICAL ALTITUDES*: 2,000–45,000ft
WHERE THEY FORM: Commonin in tropical and temperate regions. Rare in polar ones.
PRECIPITATION (REACHING GROUND): Heavy downpours, often of hail.

Cumulonimbus calvus (means 'bald')

Cumulonimbus capillatus (means 'hairy')

CUMULONIMBUS SPECIES:
The two species are distinguished by the appearance of the cloud's top.
CALVUS: When the upper region is of soft indistinct flattened mounds, without any fibrous or striated appearance.
CAPILLATUS: When the upper region is cirrus-like and fibrous or striated, often in the shape of an anvil, plume or a disorderly mass of white hair.
CUMULONIMBUS VARIETIES:
There are no official varieties.

NOT TO BE CONFUSED WITH...
NIMBOSTRATUS: which is a dark, ragged precipitating layer, covering the sky. It can look similar to a Cumulonimbus that is directly overhead (and also appears to cover much of the sky) but the precipitation will tend to be more steady and more persistent than the short heavy showers of the Cumulonimbus. If thunder, lightning or hail is present, then the cloud is a Cumulonimbus.
CUMULUS CONGESTUS: from which a Cumulonimbus often develops. Seen from a distance, the cloud is said to have changed into a Cumulonimbus when parts of its upper region begin to lose their sharp edges, due to the droplets freezing into ice crystals. Thunder, lightning or hail will also identify the Cumulonimbus.

* These approximate altitudes (above the surface) are for mid-latitude regions.

HOW TO SPOT

STRATUS CLOUDS

Stratus are grey layers or patches of cloud, with very diffuse edges. They are the lowest-forming of all the cloud genera, sometimes appearing at ground level, when they are called fog or mist.

TYPICAL ALTITUDES*: 0–6,500ft
WHERE THEY FORM: Worldwide. Most commonly around coasts and mountains.
PRECIPITATION (REACHING GROUND): No more than occasional drizzle, snow or snow grains.

Stratus undulatus translucidus

Stratus fractus

STRATUS SPECIES:
NEBULOSUS: By far the most common, when it is in a grey, generally featureless layer.
FRACTUS: When it is in separate, ragged shreds of grey cloud. This can appear in the region below precipitating clouds, when it is called 'pannus'. Though not particularly thick, these shreds can look quite dark against the base of the cloud above.

STRATUS VARIETIES:
OPACUS: When the layer is thick enough to completely mask the sun or moon.
TRANSLUCIDUS: When it is thin enough to show the outline of the sun or moon.
UNDULATUS: A rare variety, in which the layer has wavelike undulations to its surface. The surface of Stratus is rarely distinct enough for this to be observed.

NOT TO BE CONFUSED WITH...
CIRROSTRATUS: which is a high layer cloud that can look similar to a very thin Stratus. Being made of ice, however, it has a whiter look.
ALTOSTRATUS: which is a mid-level layer cloud, often consisting of droplets, like Stratus. Through a layer of Stratus, the outline of the Sun (when it is discernible) is less diffuse, compared with the 'ground-glass' appearance of the Altostratus.
NIMBOSTRATUS: which is a thick, dark layer of precipitating cloud that might be confused with a thick Stratus. But this has a less ragged base than the Nimbostratus and produces lighter precipitation.

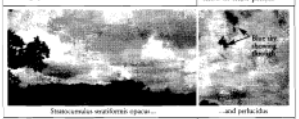
* These approximate altitudes (above the surface) are for mid-latitude regions.

HOW TO SPOT

STRATOCUMULUS CLOUDS

Stratocumulus are low layers or patches of cloud, with well-defined bases. They are usually composed of clumps or rolls, and often show strong variations in tone – from bright white to dark grey. Their cloud elements may be joined into continuous, unbroken layers or have gaps between them.

TYPICAL ALTITUDES*: 2,000–6,500ft
WHERE THEY FORM: Worldwide – it's a very common cloud.
PRECIPITATION (REACHING GROUND): Occasionally light rain, snow or snow pellets.



Stratocumulus stratiformis opacus ...

...and perlucidus

STRATOCUMULUS SPECIES:

STRATIFORMIS: The most common, when the clumps or rolls extend over a large area. A 'roll cloud' is a particular formation, in the shape of a large, individual tube of cloud.
LENTICULARIS: When one or more mass of cloud is in a smooth, solid-looking almond or lens shape.
CASTELLANUS: When the elements have crenellated tops.

STRATOCUMULUS VARIETIES:

OPACUS: When the layer is thick enough to completely mask the sun or moon.
TRANSLUCIDUS: When it is thin enough to show the outline of the sun or moon.
PERLUCIDUS: When there are gaps between the cloud elements.
DUPLICATUS: When there are layers at different altitudes, sometimes partly merged.
UNDULATUS: When the elements are arranged in nearly parallel lines.
RADIATUS: When lines of closely bunched elements appear to converge towards the horizon.
LACUNOSUS: When the layer shows large net-like holes fringed with cloud.

NOT TO BE CONFUSED WITH...

CUMULUS: which is also clumpy, well defined, and forms at similar altitudes. The elements of Stratocumulus tend to be closer together and to have flatter tops.
ALTOCUMULUS: which is a mid-level layer of cloudlets. These appear smaller than the Stratocumulus elements, which – looking above 30° from the horizon – appear larger than the width of three fingers, held at arm's length.
STRATUS: which is a low, indistinct layer, with much less variation in tone and less definition than Stratocumulus.

* These approximate altitudes (above the surface) are for mid-latitude regions.

HOW TO SPOT

ALTOCUMULUS CLOUDS

Altocumulus are mid-level layers or patches of cloudlets, in the shape of rounded clumps, rolls or almonds/lenses. These are white or grey, and the sides away from the Sun are shaded. Altocumulus are usually composed of droplets, but may also contain ice crystals.

TYPICAL ALTITUDES*: 6,500–18,000ft
WHERE THEY FORM: Worldwide.
PRECIPITATION (REACHING GROUND): Very occasionally causes light rain.

ALTOCUMULUS SPECIES:

STRATIFORMIS: Most common, when the cloudlets extend over a large area.
LENTICULARIS: When it is in the form of one or more individual almond- or lens-shaped masses that appear dense, with pronounced shading.
CASTELLANUS: When the cloudlets have crenellated tops.
FLOCCUS: When the cloudlets are Cumulus-like tufts, with ragged bases, often with fibrous trails (virga) of ice crystals falling below.

Altocumulus stratiformis undulatus

Altocumulus lenticularis

Altocumulus floccus

Text: Stephen Cook (number 150). Below left: Mike Cook (number 1493). Below right: Terry Hart (number 1958)

ALTOCUMULUS VARIETIES:

OPACUS: When the layer is thick enough to completely mask the sun or moon.
TRANSLUCIDUS: When it is thin enough to show the outline of the sun or moon.
PERLUCIDUS: When there are gaps between the cloudlets.
DUPLICATUS: When there are layers at different altitudes, sometimes partly merged.
UNDULATUS: When the cloudlets are arranged in nearly parallel lines.
RADIATUS: When long lines of them appear to converge towards the horizon.
LACUNOSUS: When the layer shows net-like holes fringed with cloud.

NOT TO BE CONFUSED WITH...

CIRROCUMULUS: which is a higher layer of cloudlets, that appear like little grains of salt. Looking above 30° from the horizon, the larger Altocumulus cloudlets generally appear the width of between one and three fingers, held at arm's length. Also, these exhibit shading, which those of Cirrocumulus don't.
CIRRUS: which is a high cloud, whose streaks of falling ice crystals can resemble Altocumulus cloudlets showing virga, but do not have their dense-looking heads.

* These approximate altitudes (above the surface) are for mid-latitude regions.

HOW TO SPOT

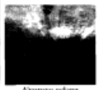
ALTOSTRATUS CLOUDS

Altostratus are mid-level layers of grey cloud, which are either featureless or fibrous in appearance, and typically extend over an area of several thousand square miles. Usually composed of both water droplets and ice crystals, they are often thin enough in parts to reveal the position of the sun, which appears as if through ground glass. Altostratus can cause a white or (when very thin) coloured 'corona' (disc of light) around the sun or moon.

TYPICAL ALTITUDES*: 6,500–23,000ft
WHERE THEY FORM: Worldwide. More common in the middle latitudes.
PRECIPITATION (REACHING GROUND): Usually not, but occasionally light rain or snow.

ALTOSTRATUS SPECIES: There are no species, as the cloud's appearance is so uniform.


Altostratus translucidus


Altostratus radiatus

ALTOSTRATUS VARIETIES:
OPACUS: When the cloud layer is generally thick enough to mask the position of the sun or moon.
TRANSLUCIDUS: When it is generally thin enough to show the position of the sun or moon.
DUPLICATUS: When there is more than one layer at different altitudes, these often being partly merged. This is generally only visible when, by the light of a low sun, the higher layer is lit and the lower is in shadow, or when shearing winds cause the striations of the layers to differ.
UNDULATUS: When the layer shows largely parallel undulations.
RADIATUS: When lengthy undulations appear to converge toward the horizon.

NOT TO BE CONFUSED WITH...
CIRROSTRATUS: which is a higher layer of ice crystals that looks like a thin, milky veil across the sky, and often thickens and lowers to develop into Altostratus. The Altostratus will tend to be more opaque, making the sunlight too diffuse for objects to cast shadows, as they do below Cirrostratus. While coloured or white discs of light, called coronae, can appear around the sun/moon through Altostratus, this cloud will not cause the 'halo phenomena' of the Cirrostratus.
NIMBOSTRATUS: which is a thick, dark layer of precipitating cloud that often develops out of an Altostratus. Generally darker, it produces considerably heavier rain or snow.

* These approximate altitudes (above the surface) are for mid-latitude regions.

HOW TO SPOT

NIMBOSTRATUS CLOUDS

Nimbostratus are thick, grey, featureless layers of cloud that cause prolonged, continuous, often heavy, rain, snow or ice pellets. They tend to have very diffuse bases, as a result of all the falling precipitation. Nimbostratus are the deepest of all the layer clouds – sometimes extending from 2,000ft up to around 18,000ft – and generally extend over many thousand square miles. As with other precipitating clouds, the falling precipitation can cause Stratus fractus to form in the air below Nimbostratus clouds. These are known as 'pannus' and appear as shreds of cloud, looking darker than the underside of the Nimbostratus. When these join together, they tend to lower the bases of Nimbostratus clouds even further. They are invariably thick enough to completely hide the sun or moon.

TYPICAL ALTITUDES*: 2,000–18,000ft
WHERE THEY FORM: Worldwide. More common in middle latitudes.
PRECIPITATION (REACHING GROUND): Causes moderate to heavy rain or snow (steady and prolonged).

NIMBOSTRATUS SPECIES: There are no species, as the cloud's appearance is so uniform.

NIMBOSTRATUS VARIETIES: There are no varieties, as the cloud's appearance is so uniform.

NOT TO BE CONFUSED WITH...
ALTOSTRATUS: which is a thinner – though also indistinct – layer of cloud. Nimbostratus is always darker than it and, by definition, produces precipitation. Altostratus only does sometimes, and this will generally be light. Whilst the position of the sun can generally be determined through at least part of a layer of Altostratus, it will never be so through a Nimbostratus.
CUMULONIMBUS: which, when observed from directly below, can also appear as a very dark layer, covering the whole sky. The precipitation falling from a Nimbostratus will not generally be as heavy and will be more prolonged and continuous, compared with the sudden showers of the Cumulonimbus. Nor will the Nimbostratus produce its hail, thunder or lightning.


Nimbostratus – never a pretty sight

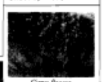
* These approximate altitudes (above the surface) are for mid-latitude regions.

HOW TO SPOT

CIRRUS CLOUDS

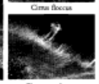
Cirrus are the highest of the ten main cloud types. In the form of delicate, white streaks, patches or bands of falling ice crystals, they are detached from each other, and have fibrous or silky appearances. Cirrus rarely appear very thick. They are often seen with the other high clouds, Cirrostratus and Cirrocumulus and, like them, can show 'halo phenomena' around the sun or moon.

TYPICAL ALTITUDES*: 16,500–45,000ft
WHERE THEY FORM: Worldwide.
PRECIPITATION (REACHING GROUND): None.



Cirrus floccus

Cirrus uncinus



Cirrus vertebratus

CIRRUS SPECIES:
FIBRATUS: When it is in the form of straight or curved filaments that are mostly distinct from each other and do not terminate in hooks or clumps.
UNCINUS: When its 'fallstreaks' are the shape of hooks or commas.
SPISSATUS: The thickest Cirrus – when it is in patches that appear grey in front of the sun – which tends to originate from the anvil of a Cumulonimbus.
CASTELLANUS: When it is in the form of small distinct clumps with crenellated tops.
FLOCCUS: When it is in the form of independent small round tufts, which often show trails of ice crystals falling from them.

NOT TO BE CONFUSED WITH...
CIRROSTRATUS: which looks like a thin, milky smooth or fibrous veil across the sky. Cirrus, by contrast, is in separated streaks, fibres or patches.
CIRROCUMULUS: which is a high layer of cloudlets, like grains of salt. Cirrus does not show this finely dappled texture.

CIRRUS VARIETIES:
INTORTUS: When the fallstreaks are irregular and tangled.
RADIATUS: When the filaments are in parallel bands, usually aligned to the wind at high altitude, which converge towards the horizon, due to perspective.
VERTEBRATUS: When the filaments look like a fish skeleton.
DUPLICATUS: When the filaments, streaks or hooks are arranged at more than one altitude, which can be apparent when the winds cause them to point in different directions.

* These approximate altitudes (above the surface) are for mid-latitude regions.

Left: Malcolm Buck (member 1770). Top right: Graham Tilson (member 562). Bottom right: Linda King (member 1419)

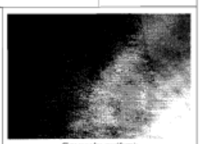
HOW TO SPOT

CIRROCUMULUS CLOUDS

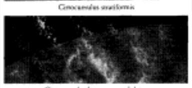
Cirrocumulus are high patches of cloud or layers of tiny cloudlets that appear as white grains. These show no shading, even on the sides away from the sun. These cloudlets are generally regularly spaced, and often arranged in ripples, known as the undulatus variety.

TYPICAL ALTITUDES*: 16,500–45,000ft
WHERE THEY FORM: Worldwide.
PRECIPITATION (REACHING GROUND): None.

CIRROCUMULUS SPECIES:
STRATIFORMIS: When it is in an extensive layer, rather than just a patch. A less common species than for other genera.
LENTICULARIS: When it is in the form of one or more independent, well-defined, almond- or lens-shaped masses, which have smooth surfaces and are much larger than the grain-like cloudlets of the other species.
CASTELLANUS: When, on careful inspection, its cloudlets have crenellated tops.
FLOCCUS: When, on careful inspection, its cloudlets are Cumulus-like, with ragged bases.



Cirrocumulus stratiformis



Cirrocumulus lacunosus undulatus

CIRROCUMULUS VARIETIES:
UNDULATUS: When its cloudlets are in a wave-like arrangement of ripples or broad undulations (or both at the same time).
LACUNOSUS: When the layer has holes fringed with cloud, like a net or honeycomb.

NOT TO BE CONFUSED WITH...
CIRRUS AND CIRROSTRATUS: which are streaks and smooth/fibrous layers of high cloud. Cirrocumulus layers, by contrast, are subdivided into many grain-like cloudlets.
ALTOCUMULUS: which is a mid-level layer of larger cloudlets. Looking above 30° from the horizon, the smaller Cirrocumulus cloudlets generally appear less than the width of one finger, held at arm's length.

* These approximate altitudes (above the surface) are for mid-latitude regions.

HOW TO SPOT

CIRROSTRATUS CLOUDS

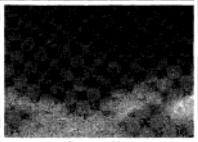
Cirrostratus are largely transparent, milky veils of high cloud that look either smooth or fibeous. They tend to cover large areas of the sky, extending over many thousands of square miles, but are often so subtle as to be missed. They do, however, sometimes produce the white or coloured rings, spots or arcs of light around the sun or moon that are known as 'halo phenomena'.

TYPICAL ALTITUDES*: 16,500–30,000ft
WHERE THEY FORM: Worldwide.
PRECIPITATION: None.

HALO PHENOMENA:

Cirrostratus causing a '22° Halo' around the moon

Cirrostratus fibratus causing a 'sundog' at the same elevation as the sun



Cirrostratus undulatus

CIRROSTRATUS SPECIES:
FIBRATUS: When the cloud veil has a fine fibrous or striated appearance.
NEBULOSUS: When it shows no variation in tone.

CIRROSTRATUS VARIETIES:
UNDULATUS: When the veil has a wave-like appearance.
DUPLICATUS: When there is more than one layer, at different altitudes. This is generally only visible when, by the light of a low sun, the higher layer is lit up when the lower is in shadow, or when shearing winds cause the striations of each layer to differ.

NOT TO BE CONFUSED WITH...
ALTOSTRATUS: which is a mid-level, generally thicker, layer cloud. Besides being thinner, the ice crystals of the Cirrostratus can sometimes produce halo phenomena around the sun or moon. These are far less common in Altostratus, which will generally only produce a corona (a white or coloured disc of light).
CIRRUS OR CIRROCUMULUS: which are streaks and grained/rippled layers of high cloud. Cirrostratus, which often appears in conjunction with them, is a more continuous and diffuse layer.

* These approximate altitudes (above the surface) are for mid-latitude regions.